Quality of Service over LTE Networks - Part 1 of 3

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Ongoing worldwide adoption of mobile devices has created unprecedented demand for access to e-commerce, social media and entertainment applications anywhere, at any time. This has not only increased the amount of mobile broadband traffic transported by the carrier networks, but also transformed its composition; mobile traffic that was traditionally voice-only is now dominated by video and data owing to applications like live video streaming, Netflix, Facebook, Twitter and mobile browsing. This trend continues to increase as the variety and number of applications and services increases, and the subscriber base grows.

The next-generation carrier networks must incorporate a high degree of intelligence to transport different types of traffic in a way that provides a satisfactory (and competitive) end-user experience, while also maximizing revenue per user. This can be achieved through Quality of Service (QoS) techniques that enable the network to identify and manage traffic based on a number of attributes, such as traffic types, relative priorities, and source and destination addresses. As the mobile carriers deploy more and more Long Term Evolution and LTE-Advanced (LTE-A) networks, comprehensive QoS capabilities will be needed to support next-generation services and applications.

This first article in a three-part series examines the driving forces for QoS in mobile networks. Parts two and three will provide a technical overview of LTE QoS framework and describe how QoS is being implemented using specialized System-on-Chip communication processors.

Factors Driving the Need for QoS

Mobile broadband subscriptions reached over 1.4 billion in 2012 and are projected to reach 6.5 billion by 2018, according to the 2012 Ericsson Mobility Report. According to IHS iSuppli Research, the number of LTE subscribers alone is expected to reach over 1.1 billion by 2016, as shown in **Figure 1** (www.isuppli.com/mobile-and-wireless-communications/news/pages/global-lte-subscribers-set-to-more-than-double-in-2013-and-exceed-100-million.aspx [1]).

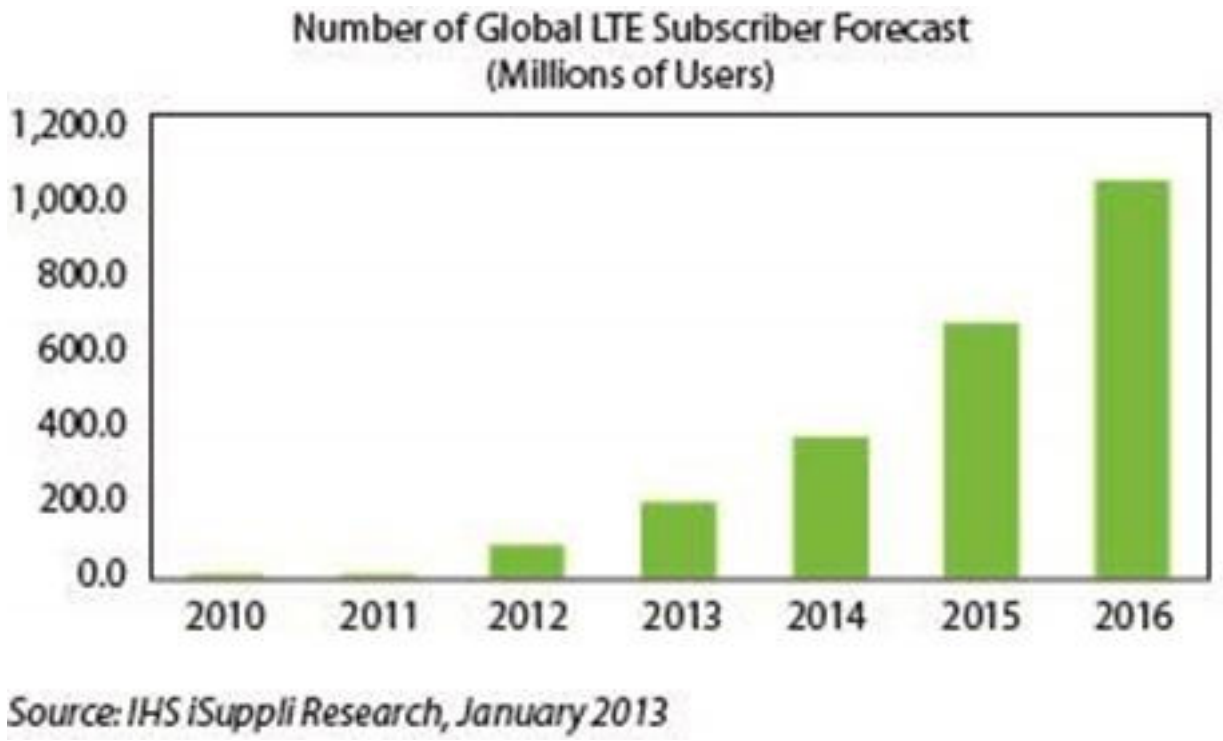

Figure 1*: LTE Subscriber Forecast*

As the number of subscribers grows, so too does the demand for an enhanced user experience with differentiated service levels. In order to attract and retain users, and maximize average revenue per user (ARPU), most mobile carriers offer differentiated service packages based on different user needs and applications. This makes QoS a fundamental component of the LTE network framework for satisfactory delivery of applications and services with effective end-to-end management of network resources. To achieve this, the LTE network elements must incorporate techniques to manage diverse traffic characteristics of the growing range of multimedia applications and services.

Applications and Services

Different applications and services place different demands on the network, and together these are driving the need for a comprehensive approach to QoS. Here are just a few examples.

Voice over Internet Protocol (VoIP) over mobile

VoIP is a technology for supporting voice communications over packet networks, such as the Internet. With modern encoding techniques, voice traffic requires relatively low bandwidth, but to deliver acceptable quality, the packets must be transmitted with minimum latency and jitter, or variation in latency. Packets associated with voice traffic must, therefore, be given very high priority and assigned to a guaranteed bandwidth channel to ensure delivery within an acceptable delay limit. Within voice traffic, differentiated, high-priority service might also be provided for important calls, such as emergency “911” calls and critical communication among emergency service personnel (based on user ID, or source and/or destination).

Video Streaming

The dramatic growth in mobile network traffic is being caused primarily by bandwidth-hungry video traffic. Real-time, user-generated and on-demand video streaming applications, such as YouTube and Hulu, are therefore a significant factor in QoS in mobile networks. For quality video/audio streaming, the network must deliver high bandwidth, but with less stringent latency and jitter requirements than VoIP. Streaming can be either person-to-person or content-to-person, and can be either real-time or recorded—all of which impose different QoS requirements. For example, real-time, person-to-person video streaming requires high bandwidth on both the uplink and downlink. So to support applications like Skype (which also uses VoIP), the network will need to provide such bi-directional QoS.

Content Download

A significant amount of mobile bandwidth is consumed by users downloading and uploading movies, pictures, music, documents, etc. Unlike with real-time video, however, these transfers are buffered and can, therefore, be handled at a more “leisurely” pace. The batch nature of such transfers enables the use of best-effort bandwidth scheduling, where packets can be dropped to accommodate higher priority traffic. Unlike with real-time traffic, which uses the User Datagram Protocol (UDP), however, batch transfers use the Transmission Control Protocol (TCP) to retransmit any and all dropped packets.

Miscellaneous services and applications

There are thousands of gaming and social media applications available for mobile platforms, and a growing number of these now require differentiated QoS. For example, multiplayer gaming requires fast, real-time responses; Facebook communications can be best-effort, but need sufficient bandwidth for uploading a video or photo.

Mobile Traffic Surges

QoS is critical to effectively managing peak-demand scenarios when a large number of users access the same application or service. Examples of these high-traffic scenarios include prescheduled events, such as a game or major speech, or breaking news somewhere around the globe. For example, during the men’s cycling race at the 2012 Summer Olympics, the unexpected amount of viewer mobile activity (tweets, live streaming, etc.) flooded the mobile network, preventing timely updates to TV broadcasters. It is critical for the mobile network to be able to instantaneously adapt to support these event-specific bandwidth and latency demands, while continuing to support special features like the tracing of traffic from emergency “911” calls.

Monetizing Mobile Networks

The ever-present need to make money applies fully to the user quality of

experience for many of today's mobile applications and services. In fact, monetization is a major driving force behind the need for enhanced QoS in mobile networks. Mobile operators face enormous pressure to maximize the return on investment (ROI) while keeping up with the rapid changes in application characteristics, and the growing diversity in subscriber needs and preferences. In effect, the service differentiation afforded by QoS provides the ability both to increase ARPU and to utilize available bandwidth more efficiently.

Monetizing with QoS requires that the network operator be able differentiate among subscribers based on their particular needs, and to offer differentiated or even user-customizable service packages with specific Service Level Agreements (SLAs), as shown in **Figure 2**. LTE SLAs should also incorporate latency-related guarantees to establish pricing tiers based on the users' quality of experience. Indeed, the bottom line to a better bottom line requires optimizing the utilization of bandwidth by prioritizing "premium" subscribers and services without creating a need to over-provision the end-to-end infrastructure to accommodate the occasional worst-case traffic scenario.

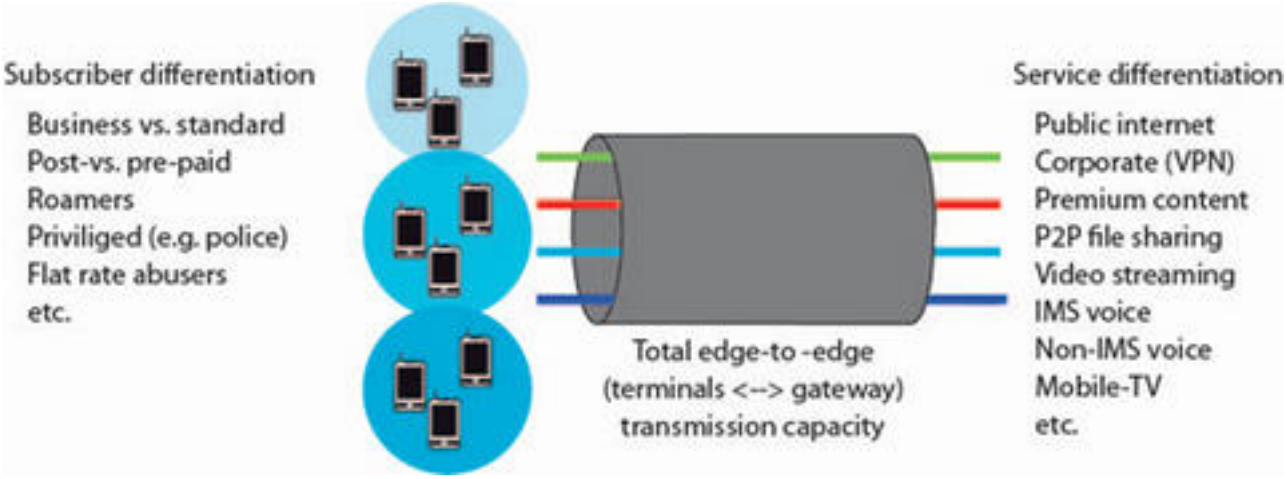

***Figure 2**: Service and Subscriber Differentiation*

The next article in the series will outline the technical requirements of the LTE QoS framework, including the critical parameters and policy controls, and how these fit into the LTE architecture [2].

For more informaiton visit www.lsi.com [3].

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